Clinical Update

Naval Postgraduate Dental School
Navy Medicine Professional Development Center
8955 Wood Road
Bethesda, Maryland 20889-5628

Vol. 36, No. 4 April 2014

Current Chairside CAD/CAM Systems and Materials for Dental Restorations

Lieutenant Katherine L. Cheng, DC, USN and Captain Scott Kooistra, DC, USN

Introduction

The use of computer aided design/computer assisted manufacturing (CAD/CAM) in dentistry began over 28 years ago. This technology allows a digital image of a tooth preparation to be designed into a restoration and then milled by a machine, thus avoiding impression-making. CAD/CAM systems can be categorized as either chairside or lab-based, and this paper will review chairside systems and capabilities. It is currently possible to perform chairside milling of a number of different restorations, including inlays/onlays, veneers, single crowns, endocrowns, fixed partial dentures, and implant abutments. Millable materials include glass-containing and polycrystalline ceramics, certain metals, composite, acrylic, and hybrid materials, and the available options continue to expand.

Advantages to using CAD/CAM technology are numerous. In addition to eliminating the final impression and lab requirements, the quality of dental prostheses has improved significantly by means of standardized production processes, and the technology has made it possible to machine high performance ceramics and titanium with high accuracy[1].

There are, however, drawbacks. The equipment is typically very expensive and can take up a significant amount of room. Training is required for the operator and auxiliary staff. Tooth preparations may need to account for limitations of the milling system. Closed-data systems in which all components are linked by a unique data format prevent different systems from interacting[2]. The purpose of this clinical update is to review common chairside CAD/CAM systems and milling materials currently available.

Chairside CAD/CAM Systems

CEREC® Acquisition Center (AC) with Bluecam (Sirona Dental Sytems) and Omnicam (Sirona) The CEREC® system is the most popular CAD/CAM system and is now in its fourth major evolution. In 2009, Sirona released the CEREC® Acquisition Center unit powered by Bluecam, a LED camera that allows for higher resolution virtual models compared to earlier models[3]. An updated version of the software, CEREC® 4.0, was released in 2012. In 2012, Sirona unveiled Omnicam in which image capture is done via digital streaming and is in full color[4].

E4D Dentist™ (D4D Technologies) The E4D system, introduced in 2008, is an in-office system that utilizes an intraoral laser scanner. Multiple scans from various angles are taken to maximize data collection and allow the software to re-create true morphology. This system allows for the fabrication of inlays/onlays, veneers, and crowns in one appointment[5]. The scanner, termed the IntraOral Digitizer, has a shorter vertical profile than that of CEREC®, so the patient is not required to open as wide for posterior scans[6].

iTero™ (Cadent, Inc.) The iTero™ system, introduced in 2007, has only CAD features chairside. The scanner projects 100,000 beams of red light, and the reflected light is converted into digital data—21 images—which are sent to Cadent for fabrication of a plastic model which is then returned to a local laboratory in order to complete the final restoration[6].

Lava™ C.O.S. (3M™ ESPE) The Lava™ Chairside Oral Scanner, introduced in 2008, uses active wavefront sampling to capture 3D data in a video sequence creating a highly accurate virtual on-screen model simultaneously. The camera contains 192 LEDs and 22 lenses. Data are sent to 3M™ ESPE where a stereolithography model is generated and then sent to a laboratory[6].

Chairside CAD/CAM Materials

The following ceramic materials are indicated for inlays/onlays, crowns, endocrowns, and veneers.

Vitablocs® Mark II (Vident™) Feldspathic blocks that are available as monochromatic blocks or multicolored blocks[1].

Triluxe blocks (Vident™) Multicolored feldspathic blocks[1].

RealLifeblock (Vident™) A Feldpathic block that utilizes a 3D radial gradient of color and translucency from the internal portion of the block to the external portion of the block to simulate the natural transition from dentin to enamel[7].

CEREC blocs (Sirona Dental Systems) Feldpathic blocks similar to Vitablocs® Mark II that feature three different degrees of color saturation: translucent, medium, and opaque [7].

IPS Empress® CAD (Ivoclar Vivadent) A leucite-reinforced block available in high and low translucency versions. Multicolored blocks are also available[7].

IPS e.max® CAD (Ivoclar Vivadent) Lithium disilicate blocks milled in a precrystallized, intermediate-strength, lithium-metasilicate crystal "blue state" to maximize milling functionality. Staining and glazing occur during the crystallization process. The flexural strength of these blocks (360 to 400 MPa) is approximately two-and-a-half times greater than that of feldspathic porcelain blocks[3].

Paradigm™ MZ100 (3M ESPE) The Paradigm™ MZ100 composite resin blocks are a highly filled (85-90% by weight) ultrafine silica ceramic particle embedded in a bisphenol A-glycidyl methacrylate matrix[3]. Advantages to using composite blocks are the ability to add to the restoration chairside by bonding composite to the air-abraded surface and the polymer chemistry which makes it easier to adjust and polish intraorally[8]. Compared to ceramic CAD/CAM restorations, composite blocks exhibit significantly higher wear but significantly lower wear to the opposing dentition[9].

Lava™ Ultimate (3M™ ESPE) Recently released, this composite material integrates nanotechnology and ceramics. The block is made of silica and zirconia particles—as well as agglomerated nanoparticles of each—that are all embedded in a highly cross-linked polymer matrix. The inclusion of nanoparticles offers the potential for easy contouring and creation of a high gloss surface finish. In vitro studies have indicated that this new material is resistant to toothbrush abrasion and retains the initial glossy surface finish, which tends to be a limitation of other CAD/CAM resin composite blocks[7].

Vita Enamic® (Vident™) A hybrid material that combines the characteristics of ceramic and composite. Known as a polymer-infiltrated-ceramic-network, the fine-structure ceramic network (80% by wt.) is strengthened by a polymer network, and both networks fully integrate with one another[10].

Vita CAD-Temp (Vident™) A highly cross-linked, microfilled polymer used to fabricate single and multi-unit provisional restorations[7].

Telio CAD (Ivoclar Vivadent) A millable cross-linked polymethylmethacrylate block for temporary crowns and fixed partial dentures. It is part of the Telio system that includes a self-curing composite, desensitizer, and cement[7].

Lab-Based CAD/CAM Systems

There are numerous lab-based systems that fabricate full-contour restorations in addition to cores, copings and frameworks for crowns, fixed partial dentures, implant superstructures and other complex prostheses. Examples include CEREC® inLab (Sirona), Everest (Kavo), Cercon® (Dentsply), Lava™ (3M™), Amann-Girrbach, and many others. Reviewing lab-based systems is beyond the scope of this paper, and information on these can be found elsewhere.

Conclusions

Laboratory-processed indirect restorations typically require a minimum of two or three appointments to complete. Because CAD/CAM restorations can be fabricated and delivered in a single appointment, they provide an expedient alternative to traditional techniques. Although there have been relatively few well-controlled long-term clinical studies reported in the literature, one systematic review of CAD/CAM single-tooth restorations found a survival rate of 91.6% after 5 years[11], and recent publications have shown 100% survivability of lithium disilicate CAD/CAM restorations after two years[3, 12]. While more long-term clinical trials are needed to fully assess the longevity of different CAD/CAM restorations, there is significant evidence that, when used appropriately, such restorations provide an acceptable alternative to conventional approaches .

References

1. Beuer F, Schweiger J, Edelhoof D. Digital dentistry: an overview of recent developments for CAD/CAM generated restorations. British Dental Journal. 2008; 204 (9):505-511.
2. Strub J, Rekow D, Witkowski S. Computer-aided design and fabrication of dental restorations. J Am Dent Assoc. 2006 Sep;137(9):1289-1296.
3. Fasbinder D, Dennison J, Heys D, Neiva G. A clinical evaluation of chairside lithium disilicate CAD/CAM crowns—A two year report. J Am Dent Assoc. 2010 Jun;141 Suppl 2:10S-14S.
4. Puri, S. The state of digital dentistry in 2012. Dentaltown 2012 Dec; 126-131.
5. Liu P, Essig M. A panorama of dental CAD/CAM restorative systems. Compend Contin Educ Dent. 2008 Oct;29(8):482-486-8.
6. Birnbaum N, Aaronson H. Dental impression using 3D digital scanners: virtual becomes reality. Compend Contin Educ Dent. 2008 Oct;29(8);494, 496, 498-505.
7. Fasbinder D. Chairside CAD/CAM: An overview of restorative material options. Compend Contin Educ Dent. 2012 Jan;33(1):50, 52-8.
8. Fasbinder D. Restorative material options for CAD/CAM restorations. Compend Contin Educ Dent. 2002 Oct;23(10):911-6, 918, 920.
9. Kunzelman K, Jelen B, Mehl A, Hickel R. Wear evaluation of MZ100 compared to ceramic CAD/CAM materials. Int J Comput Dent. 2001 Jul;4(3):171-84.
10. Coldea A, Swain M, Thiel N. Mechanical properties of polymer-infiltrated-ceramic-network materials. Den Mater. 2013 Apr;29(4):419-26.
11. Wittneben J, Wright R, Weber H, Gallucci G. A systematic review of the clinical performance of CAD/CAM single-tooth restorations. Int J Prosthodont. 2009 Sep-Oct;22(5):466-71.
12. Reich S, Fischer S, Sobotta B, Klapper H, Gozdowski S. A preliminary study on the short-term efficacy of chairside computer-aided design/computer-aided manufacturing-generated posterior lithium disilicate crowns. Int J Prosthodont. 2010 May-Jun;23(3):214-6.

LT Katherine Cheng is the General Dentistry Department Head at Camp Hansen serving with 3rd Dental Battalion, Okinawa, Japan. CAPT Scott Kooistra is the Chairman of the Operative Department at the Naval Postgraduate Dental School in Bethesda, MD and US Navy Operative Dentistry Specialty Leader.

The Naval Postgraduate Dental School is affliated with the Uniformed Services University of the Health Sciences' Postgraduate Dental College.